Unit Title: Matter and Energy in an Ecosystem

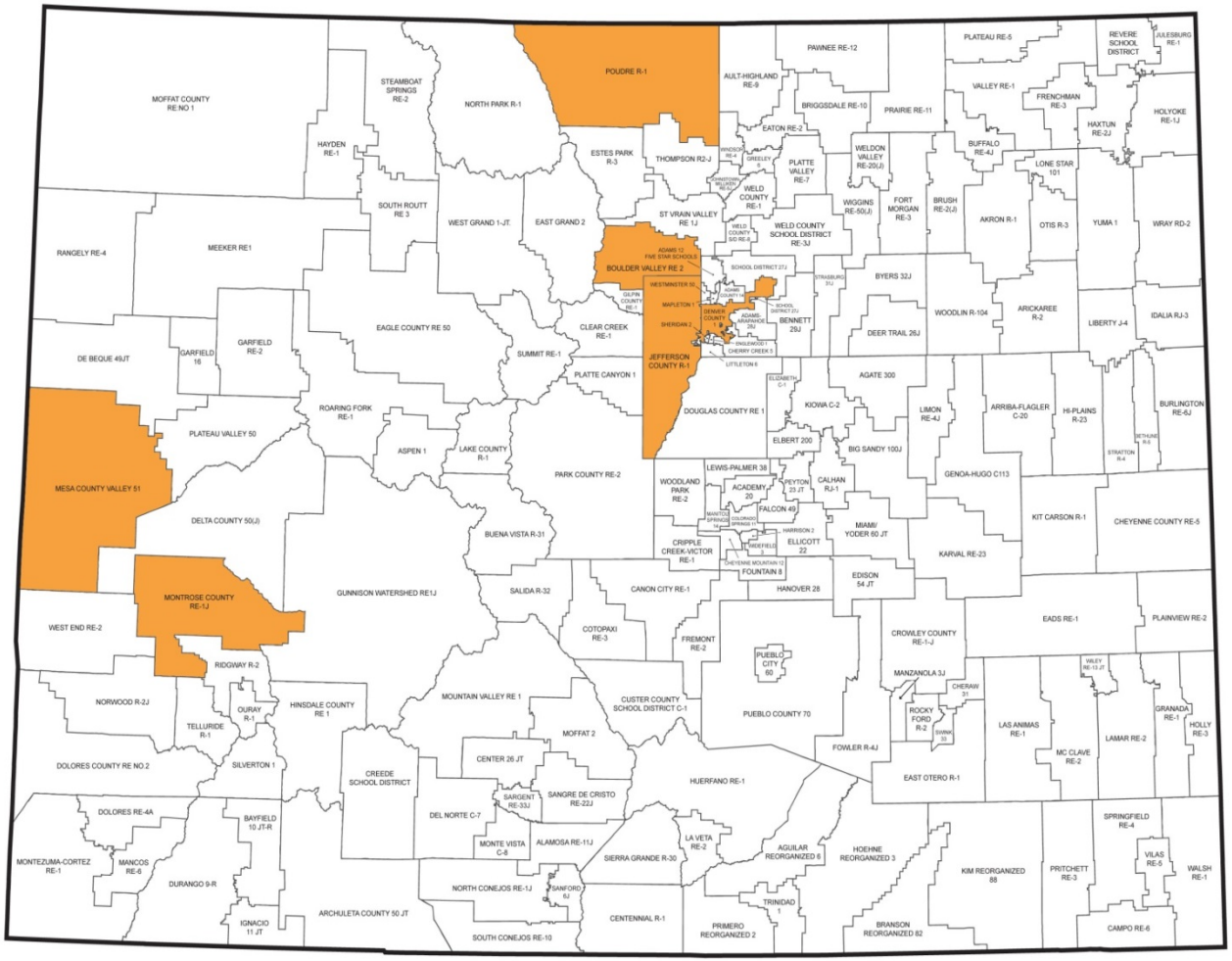
INSTRUCTIONAL UNIT AUTHORS

Mesa County 51 School District
Terri Lefebre
Denver Public Schools
Trevor Nichols
Montrose County School District
Doug Eccher

BASED ON A CURRICULUM OVERVIEW SAMPLE AUTHORED BY

Boulder Valley School District
Tammy Hearty
Jefferson County School District
Chalee McDougal
Poudre School District
Laura Grissom

Funding for this instructional unit generously provided by:



This unit was authored by a team of Colorado educators. The template provided one example of unit design that enabled teacher-authors to organize possible learning experiences, resources, differentiation, and assessments. The unit is intended to support teachers, schools, and districts as they make their own local decisions around the best instructional plans and practices for all students.

DATE POSTED: JANUARY 07, 2016

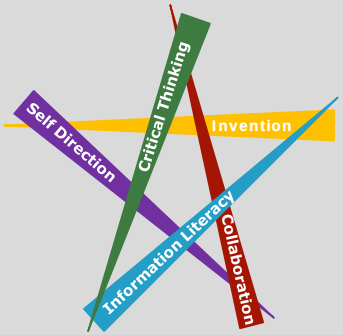
Colorado Teacher-Authored Sample Instructional Unit

Content Area	Science	**Grade Level**	High School
Course Name/Course Code	Environmental Science		

Standard	**Grade Level Expectations (GLE)**	**GLE Code**
1. Physical Science	1. Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations	SC09-GR.HS-S.1-GLE.1
	2. Matter has definite structure that determines characteristic physical and chemical properties	SC09-GR.HS-S.1-GLE.2
	3. Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy	SC09-GR.HS-S.1-GLE.3
	4. Atoms bond in different ways to form molecules and compounds that have definite properties	SC09-GR.HS-S.1-GLE.4
	5. Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined	SC09-GR.HS-S.1-GLE.5
	6. When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases	SC09-GR.HS-S.1-GLE.6
2. Life Science	1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem	SC09-GR.HS-S.2-GLE.1
	2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem	SC09-GR.HS-S.2-GLE.2
	3. Cellular metabolic activities are carried out by biomolecules produced by organisms	SC09-GR.HS-S.2-GLE.3
	4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken.	SC09-GR.HS-S.2-GLE.4
	5. Cells use the passive and active transport of substances across membranes to maintain relatively stable intracellular environments	SC09-GR.HS-S.2-GLE.5
	6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments	SC09-GR.HS-S.2-GLE.6
	7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins	SC09-GR.HS-S.2-GLE.7
	8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome	SC09-GR.HS-S.2-GLE.8
	9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment	SC09-GR.HS-S.2-GLE.9

3. Earth Systems Science	1. The history of the universe, solar system and Earth can be inferred from evidence left from past events	SC09-GR.HS-S.3-GLE.1
	2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways	SC09-GR.HS-S.3-GLE.2
	3. The theory of plate tectonics helps to explain geological, physical, and geographical features of Earth	SC09-GR.HS-S.3-GLE.3
	4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere	SC09-GR.HS-S.3-GLE.4
	5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources	SC09-GR.HS-S.3-GLE.5
	6. The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes	SC09-GR.HS-S.3-GLE.6
	7. Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms	SC09-GR.HS-S.3-GLE.7

Colorado 21st Century Skills



Critical Thinking and Reasoning: *Thinking Deeply, Thinking Differently*

Information Literacy: *Untangling the Web*

Collaboration: *Working Together, Learning Together*

Self-Direction: *Own Your Learning*

Invention: *Creating Solutions*

Reading & Writing Standards for Literacy in Science and Technical Subjects 6 - 12

Reading Standards

- Key Ideas & Details
- Craft And Structure
- Integration of Knowledge and Ideas
- Range of Reading and Levels of Text Complexity

Writing Standards

- Text Types & Purposes
- Production and Distribution of Writing
- Research to Construct and Present Knowledge
- Range of Writing

Unit Titles	Length of Unit/Contact Hours	Unit Number/Sequence
Matter and Energy in an Ecosystem	5-6 weeks	2

Unit Title	Matter and Energy in an Ecosystem	**Length of Unit**	5-6 weeks
Focusing Lens(es)	Transformation	**Standards and Grade Level Expectations Addressed in this Unit**	SC09-GR.HS-S.2-GLE.1 SC09-GR.HS-S.2-GLE.4 SC09-GR.HS-S.1-GLE.3 SC09-GR.HS-S.1-GLE.4 SC09-GR.HS-S.1-GLE.6
Inquiry Questions (Engaging-Debatable):	• Why is the sun the ultimate source of energy for all life? • How does energy transform and support life on earth?		
Unit Strands	Life Science		
Concepts	Energy, Transformation, Matter, Cycle, Interdependence, Conservation, Ecosystem		

Generalizations **My students will Understand that…**	**Guiding Questions** **Factual**	**Conceptual**
Ecosystems function through the transformation of matter and energy (SC09-GR.HS-S.2-GLE.1-EO.d,e,f)	How is matter cycled through an ecosystem? (SC09-GR.HS-S.2-GLE.1-EO.e,f) How is energy transformed in an ecosystem? (SC09-GR.HS-S.2-GLE.1-EO.a,e) What is more important to an ecosystem, decomposers or plants? (SC09-GR.HS-S.2-GLE.1-EO.e,f)	What transformations occur within an ecosystem? (SC09-GR.HS-S.2-GLE.1) Why is nitrogen transformation necessary in an ecosystem? (SC09-GR.HS-S.2-GLE.1-EO.f)
Survival of species and the proper functioning of ecosystems requires conservation of matter and energy (SC09-GR.HS-S.2-GLE-1-EO.d) and (SC09-GR.HS-S.1-GLE.3)	How is matter conserved in an ecosystem?(SC09-GR.HS-S.2-GLE.1-EO.d,e,f) How is energy conserved in an ecosystem?(SC09-GR.HS-S.2-GLE.1-EO.d,e)	What happens when the cycling of matter in an ecosystem is disrupted? (SC09-GR.HS-S.2-GLE.1-EO.c;IQ.2) How do humans impact the energy flow in rainforest ecosystems? (SC09-GR.HS-S.2-GLE.1-EO.c;IQ.2) How does agriculture affect matter cycles neighboring ecosystems? (SC09-GR.HS-S.2-GLE.1-EO.c;IQ.2)
Interdependence drives ecosystem relationships that support all life (SC09-GR.HS-S.2-GLE.4-EO.b; RA.1,2)	How are heterotrophs dependent on autotrophs? (SC09-GR.HS-S.2-GLE.4-EO.b)	How are plants and decomposers dependent on each other? (SC09-GR.HS-S.2-GLE.1)

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• Matter cycles within an ecosystem (SC09-GR.HS-S.2-GLE.1-EO.d,e,f) • How energy is conserved and transformed within an ecosystem (SC09-GR.HS-S.2-GLE.1-EO.a,d,e) • How energy lost through life processes (SC09-GR.HS-S.2-GLE.1-EO.e) • Purpose of, resources for, outcomes of, and interdependence between photosynthesis and cellular respiration (SC09-GR.HS-S.2-GLE.4-EO.a,b,c) • Heterotrophs conduct cellular respiration and autotrophs conduct both photosynthesis and cell respiration (SC09-GR.HS-S.2-GLE.4-EO.b) • The role of ATP in photosynthesis and cell respiration (SC09-GR.HS-S.2-GLE.4-EO.c)	• Describe the importance of matter cycles within an ecosystem SC09-GR.HS-S.2-GLE.1-EO.f) • Explain the transformation of energy in an ecosystem SC09-GR.HS-S.2-GLE.1-EO.d,e) • Analyze data demonstrating the energy lost between trophic levels in an ecosystem (SC09-GR.HS-S.2-GLE.1-EO.e,g) • Examine the relationship between photosynthesis and cell respiration at the chemical level (SC09-GR.HS-S.2-GLE.4-EO.b) • Diagram the movement of a carbon atom through its cycle (SC09-GR.HS-S.2-GLE.4-EO.b) • Compare how energy is obtained between autotrophs and heterotrophs, including the role of ATP (SC09-GR.HS-S.2-GLE.4-EO.b,c) • Explain how variables can affect the rate of photosynthesis or cell respiration SC09-GR.HS-S.2-GLE.4-EO.a;IQ.1) • Explain the role of decomposer in matter cycles (SC09-GR.HS-S.2-GLE.1-EO.a,e; IQ.2; RA.2)

Critical Language: includes the Academic and Technical vocabulary, semantics, and discourse which are particular to and necessary for accessing a given discipline.
EXAMPLE: A student in Language Arts can demonstrate the ability to apply and comprehend critical language through the following statement: *"Mark Twain exposes the hypocrisy of slavery through the use of satire."*

A student in _____ can demonstrate the ability to apply and comprehend critical language through the following statement(s):	Energy is not created or destroyed, but transformed in an ecosystem Autotrophs transform the sun's energy for use by heterotrophs Plants require water and carbon dioxide to convert solar energy into glucose, with oxygen as a byproduct Heterotrophs require oxygen and glucose to store energy as ATP, with carbon dioxide as a byproduct. Decomposers are necessary to create usable forms of matter for the ecosystem There is an optimal environment for photosynthesis and respiration to take place
Academic Vocabulary:	energy, transformation, conservation, interdependence
Technical Vocabulary:	matter, photosynthesis, cellular respiration, decomposer, autotroph, heterotroph, carbon, trophic levels, ATP

Unit Description:	In this unit, students will focus on the relationship between the conservation of matter and energy, nutrient cycles, how matter and energy are cycled through an ecosystem, and how disruptions alter the functionality of ecosystems. The unit culminates in a performance assessment where students take the role of an Environmental Consultant asked to make a recommendation on land-use practices to a group of public stakeholders.
Considerations:	It is recommended that this unit moves later in the sequence for a Biology or Environmental Course. The teacher may need to consider atomic structure and bonding within their pretest for matter. The teacher will need to consider the scope and sequence for their district to identify where the ideas presented in this unit fall. The teacher may consider purchasing the textbook "The Ecology of Colorado: Landscapes, Plants, and Wildlife of the Centennial State" by Allen B. Crockett for her/his reference for this course. (http://www.amazon.com/gp/product/1497432790?psc=1&redirect=true&ref_=oh_aui_detailpage_o01_s01) **Possible Misconceptions:** Environmentalists are "tree huggers" When organisms decompose, they just go away Energy is "made" Energy just goes away CO2 is a negative factor within the environmental system http://assessment.aaas.org/topics/ME#/ (AAAS Misconceptions and Test Item Bank)
Unit Generalizations	
Key Generalization:	Ecosystems function through the transformation of matter and energy.
Supporting Generalizations:	Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.

Performance Assessment: *The capstone/summative assessment for this unit.*	
Claims: (Key generalization(s) to be mastered and demonstrated through the capstone assessment.)	Ecosystems function through the transformation of matter and energy.
Stimulus Material: (Engaging scenario that includes role, audience, goal/outcome and explicitly connects the key generalization)	You are a consultant with an Environmental Firm asked to make a recommendation to a community stakeholder panel about land-use practices (cattle production versus chicken production versus corn production, etc.) in a least disruptive location. You must make a data-based argument for land-use with regards to transfer of energy within a local ecosystem which serves a community's food-production needs. You will argue a preferred location and food-production practice, reference efficiency of energy between trophic levels, and discuss potential consequences of your choice. You must determine what data will be needed, collected and analyzed, to provide evidence for your reasoning, and report your findings using text, graphs and data tables. You can present your findings in a mode of your choice (video, formal written report, Public Service Announcement, etc.)

Product/Evidence: (Expected product from students)	Students are asked to take the role of a consultant with an Environmental Firm asked to make a recommendation to a community stakeholder panel about land-use practices (cattle production versus chicken production versus corn production, etc.) in a least disruptive environment. They must make a data-based argument for land-use with regards to transfer of energy within a local ecosystem which serves a community's food-production needs. They need to reference efficiency of energy between trophic levels (students could include ideas around crop rotation and fertilizer use). They will choose a preferred location and food-production practice, reference efficiency of energy between trophic levels, and discuss potential consequences of your choice. They must determine what data will be needed, collect and analyze data to provide evidence for your reasoning, and report your findings using graphs and data tables. Plot location choices could be chosen by the teacher based on their local and political context. Community stakeholder group needs to reflect the student's local community. Examples include farmers, EPA, PETA, City Council, land-use planner, developer) Students must communicate through a presentation (group presentation, Environmental Impact Statement, written report, speech, editorial with a political cartoon, video documentary, or Public Service Announcement) Teacher may provide a data table with energy use/costs The teacher may invite local community members as the audience for student reports and allow feedback to be provided and revisions made. It is recommended that students review and provide feedback to their peers on their presentation and identify sources of potential bias.
Differentiation: (Multiple modes for student expression)	The teacher may allow students to report their ideas through infographics or video instead of a written form. The teacher may provide a skeletal report for students to fill in with results. The teacher may provide a communication protocol for students to follow in their reporting. The teacher may provide students with one specific plot of land for a specific organism. To extend this work, the teacher may allow students to compare more than one ecosystem. To extend this work, the teacher may provide students with opportunities to apply Geospatial Technology (GIS/GPS) to enhance data collection and or presentation of information.

Texts for independent reading or for class read aloud to support the content

Informational/Non-Fiction	Fiction
Photosynthesis by Juettner, B. [lexile level 1010] *Ecosystems* by Housel, D. [lexile level 940] *The Nitrogen Cycle* by Dakers, D. [lexile level 1020]	*My Light* by Bang, M. [lexile level 650]

The Carbon Cycle by Dakers, D. [lexile level 1050] *Earth's Water cycles* by Dakers, D. [lexile level 950] *Matter* by Cooper, C. [lexile level 1050]	

Ongoing Discipline-Specific Learning Experiences				
1.	**Description:**	Thinking like a scientist: Provide written summary/justification of data	**Teacher Resources:**	http://cfahs-science.wikispaces.com/Claim,+Evidence+and+Reasoning+(CER) (Format for how to write a summary and support with evidence) http://science.dadeschools.net/middleSchool/documents/professionalDevelopment/feb12/grade6/NSTA_resource[1].pdf (Power Point rolling out claim, evidence and reasoning)
			Student Resources:	http://school.discoveryeducation.com/sciencefaircentral/Science-Fair-Projects/Investigation-Analyze-Data-and-Draw-Conclusions.html (Walks students through the analysis of a data set in order to draw conclusions) http://www.csef.colostate.edu/Resources/Conclusion.pdf (A step-by-step guide to writing up a conclusion based on data from a scientific investigation) A guide (Writing up a conclusion to a scientific investigation) http://www.sophia.org/concepts/drawing-conclusions-based-on-data (Video presentations overviewing the process of drawing conclusions from data)
	Skills:	Identify position based on point of view Evaluate data to find conclusion Verbally or in writing, explain how data supports conclusion given a frame of reference	**Assessment:**	Students will be assessed within learning experiences
2.	**Description:**	Work like a scientist: Create and analyze graphs	**Teacher Resources:**	Power Point presentation (Dealing with identification of dependent and independent variables) http://professionaldevelopment.ibo.org/files/ocd/TaughtPractice%20with%20%20identifying%20variables.pdf (Practice worksheet for identifying dependent and independent variables) http://www.clemson.edu/ces/phoenix/tutorials/graph/index.html (Rules for graphing) http://www.wtamu.edu/academic/anns/mps/math/mathlab/beg_algebra/beg_alg_tut9_bar.htm#line3 (Teaches how and why to use different graphs and also teaches how to read a graph) http://www.teachervision.fen.com/skill-builder/graphs-and-charts/48946.html?page=1&detoured=1 (Provides questions to ask students as they analyze a graph)

				http://nces.ed.gov/nceskids/createagraph/default.aspx (Online way to create different types of graphs)
			Student Resources:	http://nces.ed.gov/nceskids/createagraph/default.aspx (Online way to create different types of graphs)
	Skills:	Label and title axes Identify dependent and independent variables Determine the appropriate type of graph Identify trends in graphs and tables Read different types of graphs Compare two or more sets of data to relate and draw conclusions Synthesize given information in graphic organizer	**Assessment:**	Students will create graphs using data from learning experiences in order to analyze relationships between variables. (Teachers may make real-time observations and provide feedback for students on their ability to set up a graph correctly.)
3.	**Description:**	Reading like a scientist: Read critically and extract main ideas	**Teacher Resources:**	http://www.phschool.com/eteach/language_arts/2002_12/essay.html (Strategies to help develop reading comprehension skills) http://www.readingrockets.org/article/3479/ (7 tips with resources to help students' reading comprehension)
			Student Resources:	http://www.brainpop.com/english/studyandreadingskills/readingskills/ (Reading comprehension movie and quiz) http://www.brainpop.com/english/writing/mainidea/ (Main idea movie and quiz) http://www.brainpop.com/math/dataanalysis/graphs/preview.weml (Analyzing graphs movie and quiz)
	Skills:	Comprehension of academic vocabulary Identify key points and themes Identify faults in research methods, logic, and statistical findings Scrutinize credibility of sources	**Assessment:**	Students will read existing text (journal article, newspaper, website, etc.) and/or analyze work of others to identify faults, logic, and statistical findings. (Teachers may assess academic language through observations of engagement with scientific discourse). (Teacher may provide a scientific procedure so that the students can identify faults).

4.	**Description:**	Thinking like a scientist: Scientific method and experimentation	**Teacher Resources:**	http://www.brainpopjr.com/science/scienceskills/scientificmethod/grownups.weml (Near middle of page teacher resources page with activities) http://undsci.berkeley.edu/teaching/misconceptions.php (A list of common misconceptions about the nature of science) http://undsci.berkeley.edu/teaching/ (Tips for introducing and teaching scientific method and experimentation) http://www.livescience.com/6727-invisible-gorilla-test-shows-notice.html (Video in which most people fail to observe large "gorilla" moving across room) http://www.shodor.org/succeed-1.0/forensic/teacher/lessons/observation.html (Lesson plan devoted to developing observation skills) http://blogs.loc.gov/teachers/2011/06/look-again-challenging-students-to-develop-close-observation-skills/ (Library of Congress brief of tools for helping students develop observation skills)
			Student Resources:	http://www.brainpopjr.com/science/scienceskills/scientificmethod/grownups.weml (At top of page student link for movie and activities about scientific method) http://www.glencoe.com/sites/common_assets/science/virtual_labs/E16/E16.html (Virtual lab to practice use of scientific method and experimentation) http://www.brainpop.com/science/scientificinquiry/scientificmethod/preview.weml (Movie and quiz for scientific method/inquiry) http://lifehacker.com/5960811/how-to-develop-sherlock-holmes+like-powers-of-observation-and-deduction (Explanation of tools to increase observation skills with hook related to Sherlock Holmes)
	Skills:	Write a testable question to be answered in an experiment Design an experiment that controls for independent and dependent variables Analyze experimental results with respect to their support of the hypothesis Identify possible sources of error Critique research methodology of scientists or other students	**Assessment:**	Students will be assessed within learning experiences
5.	**Description:**	Working like a scientist: Collect and organize data	**Teacher Resources:**	https://drive.google.com/templates# (Google Drive templates) http://www.mathgoodies.com/lessons/toc_vol11.html (Students learn how develop data collection and create graph)

			Student Resources:	https://drive.google.com/templates# (Variety of different templates to capture data and create a spreadsheet) http://nces.ed.gov/nceskids/createagraph/ (Students able to create a diverse range of graphs)
	Skills:	Identify independent and dependent variable in experiment Identify what data needs to be collected Set up appropriate data table Recognize sources of error in data collection	**Assessment:**	Students may set up their own data table in order to identify the dependent and independent variables. Students may analyze data collected and recognize outliers.
6.	**Description:**	Working like a scientist: Practice laboratory safety skills	**Teacher Resources:**	http://www.flinnsci.com/teacher-resources/safety/general-laboratory-safety.aspx (General lab safety guidelines and procedures) http://www.flinnsci.com/media/396480/safety_contract_ms.pdf (Safety Contract) http://sciencewithsandy.com/safety/teacher.htm (Guidelines for teaching safety skills and activities to use with students)
			Student Resources:	http://www.youtube.com/watch?v=em23H5a9iqQ (Can you identify the safety mistakes in this video) http://www.youtube.com/watch?v=hnfiS28ANsU (Lab safety video)
	Skills:	Explain safety concerns Identify lab safety equipment	**Assessment:**	Students will demonstrate their understanding of laboratory safety or quiz students on safety practices or pre-assess understanding of safety prior to lab/activity.

Prior Knowledge and Experiences

Students should have a basic understanding of reactants and products of photosynthesis and cellular respiration, carrying capacity, basic atomic structure and bonding, matter, energy, physical versus chemical change, biotic and abiotic, autotroph, heterotroph, producers and consumers, ecosystems, food web, invasive species, niche, and identifying bias.

Vertical Articulation: The last time students have seen concepts related to this unit was in 8th, 7th, 6th, 4th, and 2nd grades.

Learning Experience # 1

The teacher may introduce energy and matter within environmental systems so that students can identify misconceptions and demonstrate their current understanding of the concepts.		
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.	
Teacher Resources:	Web link (This resource contains background info on energy)http://assessment.aaas.org/topics/EG#/ AAAS Misconceptions and Test Item Bank http://www.readwritethink.org/classroom-resources/printouts/chart-a-30226.html (KWL Chart) http://www.phet.colorado.edu (free basic atomic structure simulations: Build an atom, Build a molecule, Molecule shapes) http://www.explorelearning.com (Free 30 day trial - Gizmo simulations - Element Builder, Covalent Bonds, Balancing Chemical Equations)	
Student Resources:	Web link (This resource contains background info on energy) http://www.phet.colorado.edu (student resources and materials are availabe with the simulations) http://www.explorelearning.com (Free 30 day trial, simulations include all student support materials)	
Assessment:	Students will complete a KWL and a pretest. http://www.readwritethink.org/classroom-resources/printouts/chart-a-30226.html (KWL Chart)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow group work. The teacher may allow the use of a scribe. The teacher may provide sentence starters.	The students may be allowed to respond verbally.
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	N/A	N/A
Critical Content:	Energy within an environmental system Matter within an environmental system Basic atomic structure and chemical bonding	
Key Skills:	Identify misconceptions and prior knowledge	
Critical Language:	Matter, energy, atomic structure, identify	

Learning Experience # 2
The teacher may provide various laboratory experiences (e.g., calorimetry lab, simulations, measurement of mass of a system) so that students can develop scientific explanations demonstrating the conservation of matter.

Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.	
Teacher Resources:	http://enviroliteracy.org/ecosystems/ (resources surrounding ecosystems in the environment) http://explorelearning.com (Free 30 day trial, Gizmo simulations for element builder, covalent bonds, balancing chemical equations, calorimetry lab)	
Student Resources:	http://enviroliteracy.org/ecosystems/ (resources surrounding ecosystems in the environment) http://explorelearning.com (Free 30 day trial, simulations include all student support materials)	
Assessment:	Students will develop a scientific explanation demonstrating their understanding of conservation of matter.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may assign simulation/lab based on learning styles	The student may communicate understanding using text or non-text products.
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may offer flexible pacing and product.	The student may apply the understanding of conservation of matter to more complex scenarios.
Critical Content:	Environmental systems Law of conservation of matter Components of matter and how it interacts within a system	
Key Skills:	Develop scientific explanations around conservation of matter	
Critical Language:	systems, conservation of matter, matter, Law, develop	

Learning Experience # 3	
The teacher may provide various laboratory experiences (e.g., calorimetry lab, simulations, measurement of mass of a system) so that students can identify what energy is, how it is conserved, and how it is transformed.	
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.
Teacher Resources:	http://www.wiley.com/college/trefil/0470118547/vdl/lab_calorimeter/ (virtual calorimetry lab) https://www.youtube.com/watch?v=fHztd6k5ZXY (You tube video of earth's energy and transformation)
Student Resources:	https://www.youtube.com/watch?v=fHztd6k5ZXY (You tube video of earth's energy and transformation) https://www.youtube.com/watch?v=v6ubvEJ3KGM (You tube video on ecosystem ecology) https://www.youtube.com/watch?v=NVd9Ch44s_Y (You tube on energy in ecosystems)

Assessment:	Students will develop a scientific explanation showing understanding of conservation and transformation of energy and how it relates to matter.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may assign simulation/lab based on learning styles	The student may communicate understanding using text or non-text products.
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may offer flexible pacing and product.	The student may apply the understanding of conservation of energy to more complex scenarios.
Critical Content:	Environmental systems Law of conservation of energy Transformation of energy Forms of energy	
Key Skills:	Develop scientific explanations around the conservation of energy	
Critical Language:	systems, conservation of energy, energy, Law, develop, transformation	

Learning Experience # 4		
The teacher may engage students in a brainstorm and then provide materials so that students can model photosynthesis and cellular respiration processes demonstrating conservation of matter.		
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Interdependence drives ecosystem relationships that support all life.	
Teacher Resources:	http://www.explorelearning.com (Free 30 day trial, Gizmo simulations for the cell energy cycle and photosynthesis) https://www.youtube.com/watch?v=0IJMRsTcwcg (Bozeman science video on photosynthesis and cellular respiration)	
Student Resources:	http://www.explorelearning.com (Free 30 day trial, all simulations include complete student support materials) http://matterandenergytransformation.wikispaces.com/Cellular+Respiration (Cellular respiration model and quiz) https://www.youtube.com/watch?v=0IJMRsTcwcg (Bozeman science video on photosynthesis and cellular respiration)	
Assessment:	Students will demonstrate the process of photosynthesis and cellular respiration through creating models or simulations.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may, based on student readiness, supply varied model/simulation materials for student choice in modeling.	N/A

Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may, based on student readiness, have them design the model/simulation with limited background information or resources.	Students may create models which demonstrate law of conservation of matter in balanced chemical equation
Critical Content:	Photosynthesis Cellular Respiration ATP and ADP Homeostasis/balance within a system Develop and model chemical reactions for photosynthesis and cellular respiration	
Key Skills:	Model cellular respiration and photosynthesis	
Critical Language:	Photosynthesis, Cellular Respiration, ATP, ADP, Homeostasis, develop, model, chemical reactions	

Learning Experience # 5		
The teacher may model energy transfer via demonstrations so students can apply their understanding to analogous situations.		
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.	
Teacher Resources:	http://www.explorelearning.com (Free 30 day trial, Gizmo simulations for the cell energy cycle and photosynthesis) http://www.fishwildlife.org/files/ConEd-Field-Investigations-Guide.pdf (Field investigation guide) http://www.ecosystemservicesseq.com.au/ecosystem-functions.html (Ecosystem functionality) http://www.ngsslifescience.com/biology_lesson_plans_ecology_lab.html (Website with multiple items to assist with lesson planning and background information) http://learningcenter.nsta.org/ (Flow of matter in an ecosystem-NTSA resource)	
Student Resources:	http://www.explorelearning.com (Free 30 day trial, all simulations have complete support materials for students) http://www.shodor.org/interactivate/activities/RabbitsAndWolves/ (Simulation with activities) https://www.boundless.com/biology/textbooks/boundless-biology-textbook/ecosystems-46/ecology-of-ecosystems-256/modeling-ecosystem-dynamics-950-12210/ (Provides conceptual, analytical and simulation models of ecosystems) http://mhhe.com/biosci/genbio/virtual_labs/BL_02/BL_02.html (Simulation of ecosystems)	
Assessment:	Students will apply and adapt their understanding of energy transformation to diagram and explain via other real world situations.	
Differentiation:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)

(Multiple means for students to access content and multiple modes for student to express understanding.)	The teacher may provide adequate demonstrations that model the concept of energy transformation so students can develop their own analogies.	Student may express analogy in multiple modalities.
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	N/A	N/A
Critical Content:	Law of Conservation of Energy focusing on energy transfer Useable forms of energy through ATP and ADP Energy transfer through cellular respiration and photosynthesis	
Key Skills:	Apply concepts related to energy transfer to new real-world situations	
Critical Language:	Energy, transformation, ATP, ADP, cellular respiration, photosynthesis	

Learning Experience # 6		
The teacher may provide field experiences so that students can identify ecosystem components and their relationship to ecosystem functionality.		
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.	
Teacher Resources:	http://www.explorelearning.com (Free 30 day trial - Gizmo simulations for photosynthesis lab) http://www.fishwildlife.org/files/ConEd-Field-Investigations-Guide.pdf (Field investigation guide) http://www.ecosystemservicesseq.com.au/ecosystem-functions.html (Ecosystem functionality) http://www.ngsslifescience.com/biology_lesson_plans_ecology_lab.html (Website with multiple items to assist with lesson planning and background information) http://learningcenter.nsta.org/ (Flow of matter in an ecosystem-NTSA resource)	
Student Resources:	http://www.explorelearning.com (Free 30 day trial, all simulations have complete student support materials) http://www.shodor.org/interactivate/activities/RabbitsAndWolves/ (Simulation with activities) https://www.boundless.com/biology/textbooks/boundless-biology-textbook/ecosystems-46/ecology-of-ecosystems-256/modeling-ecosystem-dynamics-950-12210/ (Provides conceptual, analytical and simulation models of ecosystems) http://mhhe.com/biosci/genbio/virtual_labs/BL_02/BL_02.html (Simulation of ecosystems)	
Assessment:	Students will design a field investigation to identify ecosystem components which determine optimal conditions within a system and communicate cause and effect relationship in a report format. http://www.fishwildlife.org/files/ConEd-Field-Investigations-Guide.pdf (Field investigation guide)	
Differentiation:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)

(Multiple means for students to access content and multiple modes for student to express understanding.)	The teacher may choose a specific component of scientific process (variables, hypothesis, data collection, etc.) for individual students based on readiness.	N/A
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide students opportunity for extended quantitative science processes based on student readiness.	The student may communicate the relationship between variables in a quantitative versus qualitative expression.
Critical Content:	Range of tolerance in relation to balance of an ecosystem Human impacts on environmental systems Homeostasis at the micro (organism) and macro (environment) levels	
Key Skills:	Identifying variables (ecosystem components) communicate cause and effect of changing variables design a controlled experiment to test rates of photosynthesis and cellular respiration use data to support claims engage in the scientific process identify relationships of ecosystem components	
Critical Language:	Hypothesis, data, variable, controlled experiment, error, bias, photosynthesis, cellular respiration	

Learning Experience # 7	
The teacher may provide opportunities for students to explore energy transfer through trophic levels so that students can identify organisms by trophic level, the relationship to energy transfer within multiple ecosystems, and calculate the energy efficiency within the system.	
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.
Teacher Resources:	http://www.nps.gov/romo/learn/education/teacher_guide.htm (Teacher guides to various Rocky Mountain National Park ecosystems) http://learn.genetics.utah.edu/content/gsl/foodweb/ (Great Salt Lake Ecosystem) http://glencoe.mheducation.com/sites/dl/free/0078802849/383926/BL_02.html (Model ecosystems virtual lab - How does energy flow through ecosystems? - Simulation. Includes detailed instructions, data table, field guide for 5 ecosystems, audio, journal with follow-up questions, print capabilities.) http://www.explorelearning.com (Free 30 day trial - Gizmo simulations - Food chain, plants and snails) http://www.shodor.org/interactivate/activities/RabbitsAndWolves/ (Simulation with activities) https://www.boundless.com/biology/textbooks/boundless-biology-textbook/ecosystems-46/ecology-of-ecosystems-

	256/modeling-ecosystem-dynamics-950-12210/ (Provides conceptual, analytical and simulation models of ecosystems) http://learningcenter.nsta.org/ (Flow of matter in an ecosystem-NTSA resource)
Student Resources:	http://www.explorelearning.com (Free 30 day trial, all simulations have complete student support material) http://www.shodor.org/interactivate/activities/RabbitsAndWolves/ (Simulation with activities) https://www.boundless.com/biology/textbooks/boundless-biology-textbook/ecosystems-46/ecology-of-ecosystems-256/modeling-ecosystem-dynamics-950-12210/ (Provides conceptual, analytical and simulation models of ecosystems) http://mhhe.com/biosci/genbio/virtual_labs/BL_02/BL_02.html (Simulation of ecosystems)
Assessment:	Students will diagram multiple ecosystems, calculate energy available at each trophic level, and compare energy efficiencies of various ecosystems using the Claims Evidence Reasoning (CER) framework. http://www.escofcentralohio.org/Achievement/Documents/Science%20CER%20Handout.pdf (Explanation of the CER framework)

Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	Teacher may provide scaffolding for diagramming, calculations and CER (claims-evidence-reasoning).	N/A

Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	Teacher may give students energy available at a trophic level and ask student to determine the amount at lower levels.	N/A

Critical Content:	Trophic levels within a system The role of producers, consumers, and decomposers within an ecosystem Energy transfers through food chains and food webs Energy transfer-efficiency within a system
Key Skills:	Identify organisms within trophic levels Identify energy transfer within multiple systems Calculate energy available Diagram ecosystem components Modeling (computer simulations) Analyze energy lost
Critical Language:	Trophic levels, producers, consumers, ecosystem, food chain, food web, energy transfer-efficiency, interdependence

Learning Experience # 8

The teacher may provide local human impact case studies so that students can identify cascading disruption to ecosystem functionality.		
Generalization Connection(s):	Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy	
Teacher Resources:	http://www.invasivespeciesinfo.gov/index.shtml (National Agricultural Library on Invasive Species) https://connect.d51schools.org/staff/instructional/resources/Science/High%20School/Biology/Instructional%20Resource%20Documents/Unit%201%20Ecology/succession%20activityunit1stage3.pdf (Succession in Communities) http://www.sustainable-city.org/ (This Web site outlines a sustainable city plan developed for San Francisco) http://www.explorelearning.com (Free 30 day trial - Gizmo simulation, water pollution) https://www.colorado.gov/pacific/dola/sustainability-planning (Department of Local Affairs website listing various city plans)	
Student Resources:	http://www.sustainable-city.org/ (This Web site outlines a sustainable city plan developed for San Francisco) Marine Reserves and Local Fisheries (This simulation addresses the question: What is the balance between marine biodiversity conservation and local fishery activities?) http://www.explorelearning.com (Free 30 day trial, all simulations have complete student support materials)	
Assessment:	Students will create an illustrated storyboard of ecosystem disruptions (e.g., fire suppression, invasive species, urban sprawl, etc.) to show environmental impacts.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to create the storyboard using Prezi, brochure, computerized storyboard, political cartoon, written report, etc.	N/A
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	N/A	N/A
Critical Content:	Range of tolerance within an ecosystem Balance of a system Human impact (invasive species, habitat fragmentation, development) Sustainability of resources within an ecosystem experiencing disruptions	
Key Skills:	Research ecosystem disruption Analyze the cost/benefit of disruptions to nutrient cycles and ecosystems	
Critical Language:	Range of tolerance, balance, human impact (invasive species, habitat fragmentation, development), sustainability	

Learning Experience # 9

The teacher may group students (e.g., expert groups, jigsaw) to individually gather information and research disruptions within nutrient cycles so that students can describe the significance of nutrient cycling and synthesize their understanding of the individual components in order to communicate the importance of cycling for ecosystem functionality.		
Generalization Connection(s):	Ecosystems function through the transformation of matter and energy. Interdependence drives ecosystem relationships that support all life. Survival of species and the proper functioning of ecosystems require conservation of matter and energy.	
Teacher Resources:	http://svesd.net/files/DOK_Question_Stems.pdf (Question Stems) http://www.explorelearning.com (Free 30 day trial - Gizmo simulations - Water Pollution) https://www.youtube.com/watch?v=N31UFLD9RLA (Carbon respiration and cycling)	
Student Resources:	http://www.explorelearning.com (Free 30 day trial, all simulations have complete student support materials) https://www.youtube.com/watch?v=eOfMmPGMqoA (Nutrient cycling in an ecosystem) https://www.youtube.com/watch?v=L2yb1ERU9p4 (You tube on nutrient cycles)	
Assessment:	Students will identify ecosystem components and collaboratively communicate the significance of nutrient cycling by presenting and creating peer assessment.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide sentence stems for peer feedback, higher level questioning skills, assessment structures, and Research sites.	N/A
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to investigate places where humans are using the nutrient cycle for their purposes (e.g., wastewater treatment plants, created wetlands)	The student may report their findings in a format of their choosing.
Critical Content:	Carbon cycles Nitrogen cycle Water cycle Phosphorus cycle Ecosystem functionality Nutrient availability Ecosystem balance	
Key Skills:	Research disruptions within nutrient cycles Communicate nutrient cycles importance within an ecosystem Synthesize information on the components of various nutrient cycles Diagram nutrient cycles	

	Determine the cause and effect of disruptions within nutrient cycles on ecosystem functionality
Critical Language:	Carbon cycles, nitrogen cycle, water cycle, phosphorus cycle, systems, cycling, ecosystem functionality, nutrient availability, ecosystem balance, research, communication, synthesize, diagramming